INSTRUCTION MANUAL

Telonic

INDUSTRIES, INC

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PARTS LIST
SCHEMATICS
MARKERS (Optional)

MODEL HD-3

SERIAL NO. 7514

SWEEP GENERATOR

Telonic INDUSTRIES, INC. BEECH GROVE, INDIANA

WARRANTY

TELONIC INSTRUMENTS AND ACCESSORIES

Products manufactured by TELONIC INDUSTRIES, INC. are guaranteed against defective materials and workmanship for a period of one year (vacuum tubes excepted) from date of purchase. This warranty does not apply to instruments that have been altered, improperly handled or damaged in any way beyond our control.

Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time, and to furnish merchandise in accordance with current specifications, without incurring any liability to modify equipment previously sold.

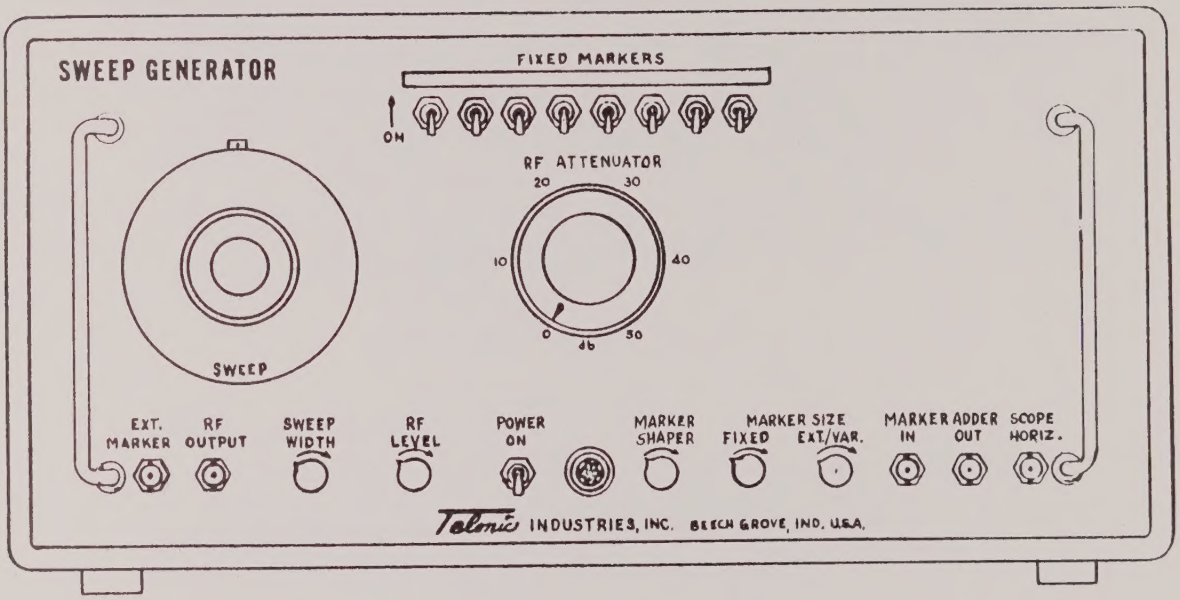
RETURNING EQUIPMENT TO FACTORY

Factory service is available for repair and readjustment of this instrument. However, a description of the trouble, plus the MODEL AND SERIAL NUMBERS of the unit should be forwarded FIRST, whereupon instructions for correcting the trouble OR authorization for returning the equipment will be given. This applies to all units, whether under warranty or not.

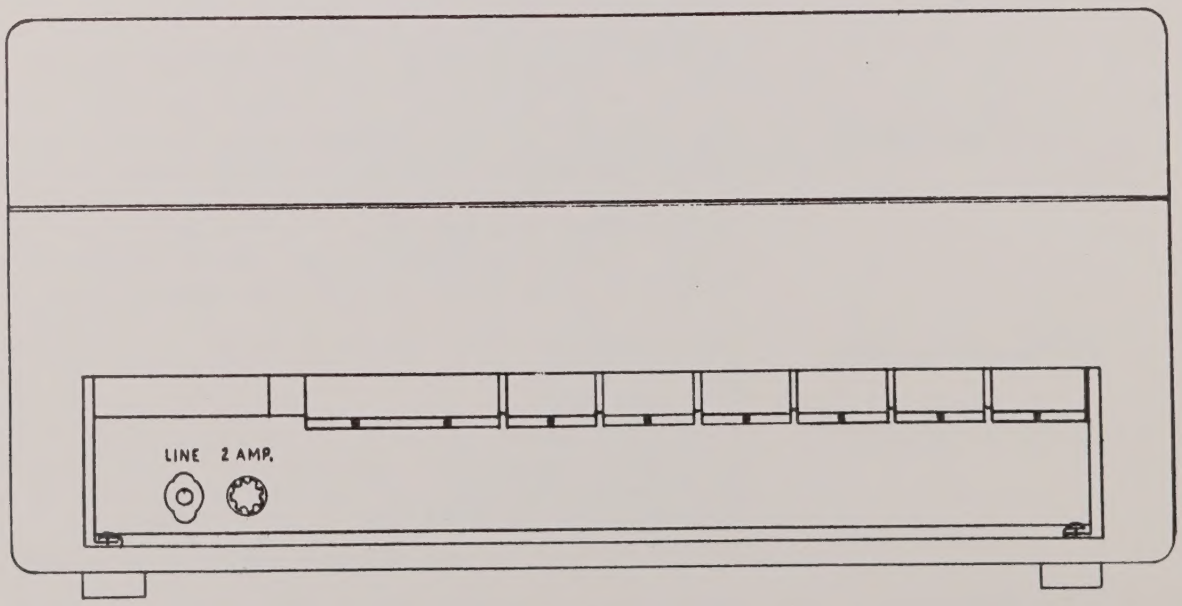
SPECIFICATIONS

MODEL HD-3 SWEEP GENERATOR

CENTER FREQUENCY	.5 to 200 MC
FREQUENCY RANGE	.5 to 300 MC
SWEEP WIDTH	200 KC to 200 MC
OUTPUT	
Voltage	0.8 volts peak to peak
Impedance	50Ω
Flatness	± 5% over maximum sweep width
ATTENUATION	
Step	0, 10, 20, 30, 40, 50 db.
Vernier	0 to over 10 db.
DISPLAY LINEARITY	Normally below 1.2:1
RADIATION	Less than 10 microvolts
SWEEP RATE	Line Frequency (50-60 cps.)
ZERO BASE LINE	Oscillator off during sweep retrace.
SCOPE HORIZONTAL SWEEP	Approximately 15 volts peak to peak.
SOURCE VSWR	Normally below 1.2:1.
POWER	115/230 Vac, 50/60 cps., Approximately 120 watts.
MARKER SYSTEM	
Birdy-By-Pass Marker Circuitry	The output of the marker oscillators is mixed with a signal from the sweep oscillator to produce beatnotes or birdies. These are amplified and superimposed upon the detected RF output signal before it is applied to the vertical scope input. Amplitude and shape of the markers are adjustable over a wide range.
External Marker Input	An external CW signal of approximately 0.1 volts may be used to produce a "birdy" type marker.
Plug-In Crystal Markers	Provisions are included for up to eight single frequency or harmonic type plug-in crystal-controlled markers. These markers are optional and may be included in this instrument or added at a later date. See our literature for further details regarding these markers.
PHYSICAL DESCRIPTION	Panel Size - 1/8" x 8 3/4" x 19". Chassis Size - 2" x 14 1/2" x 17".


SWEEP GENERATOR
FIXED MARKERS
ON
RF ATTENUATOR
20
30
10
40
0
db
50
SWEEP
EXT. MARKER
RF OUTPUT
SWEEP WIDTH
RF LEVEL
POWER ON
MARKER SHAPER
MARKER SIZE FIXED
EXT/VAR.
MARKER IN
ADDER OUT
SCOPE HORIZ.
Talmi INDUSTRIES, INC. BEECH GROVE, IND. U.S.A.

FRONT

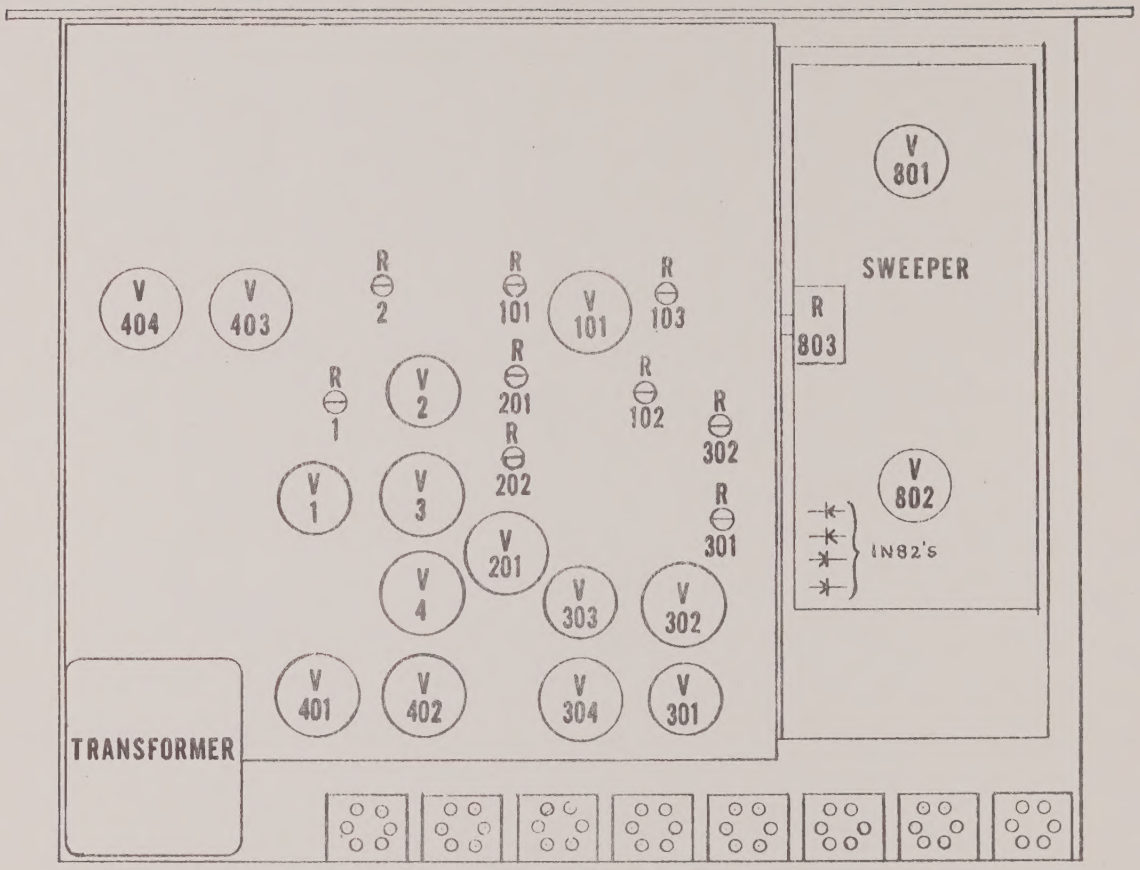

LINE
2 AMP.

REAR

DESCRIPTION OF FRONT PANEL

SWEEP DIAL	Indicates center frequency of the sweep oscillator at minimum sweep width.
RF ATTENUATOR	Turret Attenuator provides indicated amounts of attenuation.
FIXED MARKERS	These switches supply B+ to the fixed markers (crystal plug-in units) when in the on position.
EXTERNAL MARKER	Marker input for external signal source.
RF OUTPUT	RF sweep output - BNC Connector - Impedance 50 ohms.
SWEEP WIDTH	Varies the amount of voltage supplied to the vibrating capacitor and can be used to vary the sweep width.
RF LEVEL	Determines the average B+ supplied to the sweep oscillator and may be used as a vernier level control.
POWER ON	Switches AC power on and off.
MARKER SHAPER	Varies the width of the marker signals.
MARKER SIZE	
Fixed	Varies the amplitude of the fixed markers (crystal plug-in units).
Ext/Var	Varies the amplitude of the external marker signals.
MARKER ADDER	
In	The demodulated signal from the device being tested is fed into this connector so that marker signals may be superimposed.
Out	This connector should be connected to the vertical input terminals of the scope for viewing the demodulated signal and markers
SCOPE HORIZONTAL	This connector should be connected to the scope horizontal amplifier input.

CHASSIS LAYOUT

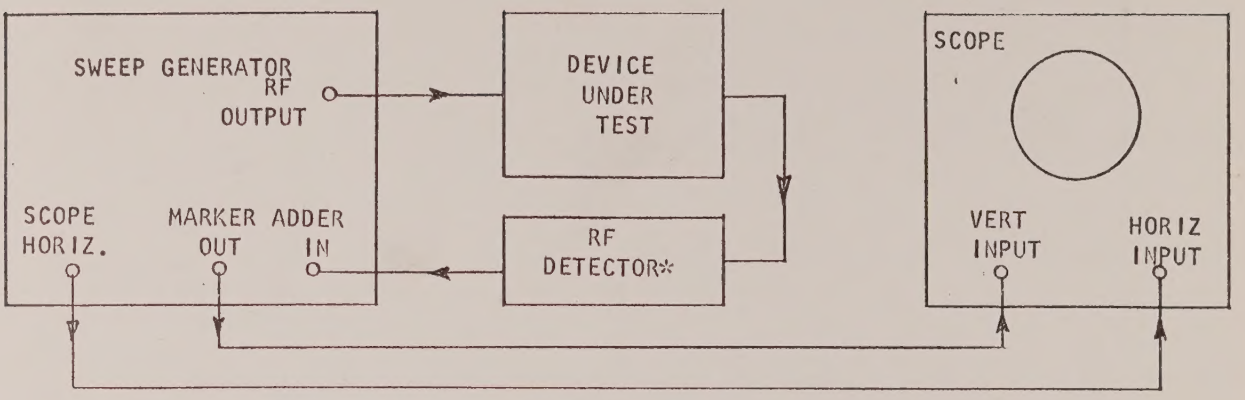


V1	5651
V2	6AU6
V3	EL84/6BQ5
V4	EL84/6BQ5
V101	12AX7
V201	12AX7
V301	6AU6
V302	12AX7
V303	6AU6
V304	EL84/6BQ5
V401	12AX7
V402	12AX7
V403	12AX7
V404	12AX7
V801	6AF4
V802	6AF4

DESCRIPTION OF CHASSIS CONTROLS

R1 - B+ ADJUST	This control varies the bias on the amplifier, (V2), for the B+ regulator, (V3), and is adjusted to produce a regulated B+ voltage (B+2) of 175 volts.
R101 - HORIZONTAL PHASE	This control adjusts the phase of the scope horizontal sweep voltage with reference to the phase of the sweep oscillator.
R102 - LINEARITY	This control can be used to change the waveform of scope horizontal output (V101). It is normally set for best linearity at maximum sweep width.
R103 - HORIZONTAL SIZE	This control adjusts the size of the horizontal output when the Front Panel SWEEP WIDTH control is set to its maximum position. It is adjusted to maintain a constant horizontal size at all sweep width settings.
R201 - BLANKING PHASE	This control adjusts the phase of the blanking pulse with reference to the phase of the sweep oscillator.
R202 - BLANKING WIDTH	This control is the grid resistor for the blanking pulse generator (V201). It is adjusted to blank one-half of the sweep cycle to produce a zero base line.
R301 - LEVEL MAXIMUM	This control is used to adjust the output level when the front panel LEVEL control is at its maximum position.
R302 - LEVEL MINIMUM	This control is used to adjust the output level when the front panel LEVEL control is at its minimum position.
R2 - SWEEP WIDTH LIMIT (HI FREQ. SIDE OF DISPLAY) R803 - SWEEP WIDTH LIMIT (LO FREQ. SIDE OF DISPLAY)	These limit controls determine the voltage supplied to the front panel sweep width dual potentiometer and are used to adjust the sweep width when the front panel control is set to maximum. The two sweep oscillators are operating out of phase with each other and the nonlinearities present at such wide sweeps cancel out. Thus the two limit controls are set not only to provide full sweep width but are also set for best display linearity. R2 affects primarily the high frequency side of the display and R803 affects primarily the low frequency side of the display.

OPERATING INSTRUCTION



TYPICAL SET UP - The following procedure is recommended for setting up this instrument in test position.

1. Connect unit to proper power line voltage and turn POWER ON switch to ON position.

2. Make connections to the scope, the device under test, and RF Detector as shown above. All connectors located on the sweep generator are BNC type and it is recommended that RG cable be used for all connections. This insures good ground connection between each device, minimizes hum, leakage from unit and pick up of spurious external signals. The cable that is used to connect the RF OUTPUT to the device under test should match the impedance of the sweep generator. If the input impedance of the device under test is different from the impedance of the sweep generator, a matching network should be used to insure a constant input signal.

3. Adjust the RF output level by means of the OUTPUT LEVEL or VERNIER ATTENUATOR control and the step RF ATTENUATOR to the proper input signal for the device being tested. Failure to do this will result in incorrect reading on the scope.

4. Adjust the SWEEP WIDTH control and center frequency SWEEP DIAL to cover the desired frequency range.

5. MARKERS
   Markers may be produced by one or more of the following methods depending on the specific unit.
   A. Plug-in crystal markers (C type).
   B. Plug-in crystal harmonic markers (CDH or CH type).
   C. Internal variable marker.
   D. External C.W. Signal.
   First turn on marker unit or inject external C.W. signal and adjust MARKER SIZE and SHAPER until markers are of a convenient size and width.

*See Telonic literature for detector recommended for use with this instrument.

INTERNAL CONTROL ADJUSTMENT

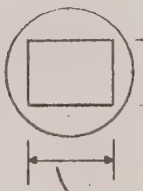
PRINTED WIRING BOARD CONTROLS are adjusted at the factory and normally do not require any readjustment. However, should it be desirable to check these adjustments, follow these steps.

1-Connect unit as shown under operating instructions but omit the device under test. The recommended detector for the unit is the Telonic XD-3. Turn unit on.

2-B+2 ADJUSTMENT: Adjust R1 to provide a regulated B+ voltage of 175 volts (blue wire).

3-BLANKING PHASE and WIDTH ADJUSTMENTS: Set SWEEP WIDTH control to its maximum counter-clockwise position; OUTPUT LEVEL control to its maximum clockwise position and the Attenuator to its 0 db. position. A rectangular pattern should appear on the scope.

Adjust SCOPE VERTICAL and HORIZONTAL SENSITIVITY controls to present a pattern as shown. Vertical amplifier should be DC coupled, pattern will deflect up or down depending on output polarity of the RF Detector. Patterns shown with Telonic XD-3 half-wave detector with negative output.



A vertical line indicates no horizontal output, first check scope and connecting cables, then trouble shoot horizontal sweep section.

A horizontal line with zero amplitude indicates no RF Output. First check scope, RF Detector and connecting cables. Adjust R301 (see step 4). Refer to Maintenance, Page 13.

A horizontal line deflected below zero indicates no blanking. Trouble shoot the blanking generator.

If pattern is not rectangular, adjust BLANKING WIDTH and PHASE controls R201 and R202.

BLANKING PHASE

Misadjusted

BLANKING WIDTH

Misadjusted

BLANKING PHASE & WIDTH

Misadjusted

4-RF OUTPUT MIN and MAX ADJUSTMENTS: Adjust LEVEL MAXIMUM control R301 until vertical height of the pattern equals $\frac{1}{2}$ of the peak to peak RF output voltage shown on the specification sheet, Page 1. Since the RF Detector is approximately 90% efficient, the actual RF output voltage will be slightly higher than the voltage shown on the scope. Turn turret attenuator to 10 db. position and record the height of the pattern. Return the turret attenuator to the 0 db. position. Turn the RF OUTPUT LEVEL control to its maximum counter-clockwise position and adjust LEVEL MINIMUM control, R302, until the height of the pattern is slightly less than it was with 10 db. inserted in the output circuit. This procedure insures that the OUTPUT LEVEL control will provide over 10 db. of vernier attenuation. An alternate method to perform the above adjustments is to use a RF power meter in place of the RF Detector. Keep in mind that the sweep oscillator is blanked off for $\frac{1}{2}$ of each cycle, therefore, the reading on the power meter will have to be doubled to obtain the actual RF output power.

INTERNAL CONTROL ADJUSTMENT

(Continued)

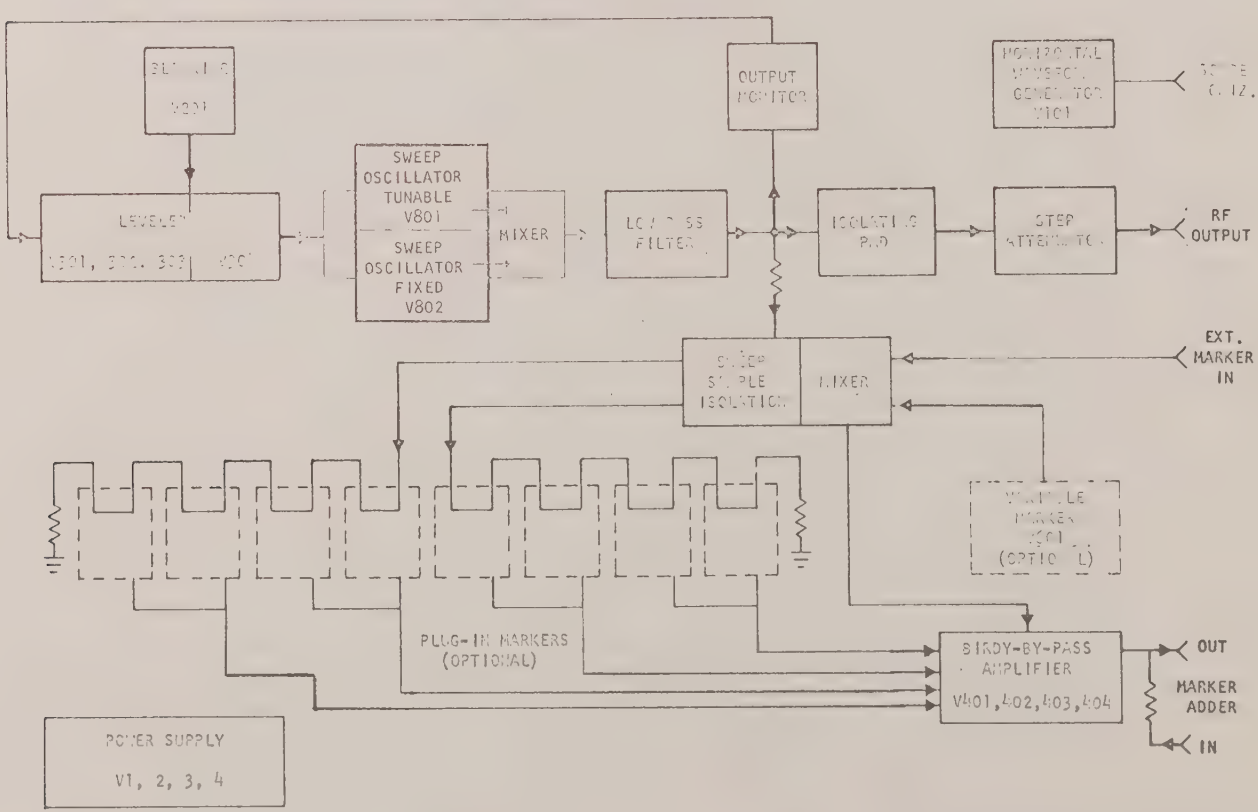
5-HORIZONTAL PHASE and SIZE ADJUSTMENTS: Return OUTPUT LEVEL control to maximum clockwise position. Set SWEEP WIDTH control to its maximum clockwise position. If pattern is not rectangular, adjust HORIZONTAL PHASE, R101, until a rectangular pattern is obtained. If Horizontal Size has increased or decreased, adjust HORIZONTAL SIZE, R103, until pattern has the same horizontal size as it had with the SWEEP WIDTH control in its counter clockwise position.

MARKERS MUST BE PROVIDED FOR THE FOLLOWING ADJUSTMENTS

6-SWEEP WIDTH ADJUSTMENT: With the sweep dial set to a center frequency of 200MC., R2 is adjusted so that the highest frequency obtained on the display is 300MC. R803 is next adjusted so that the lowest frequency present on the display is 100MC.

7-LINEARITY ADJUSTMENT: Linearity may best be adjusted when a number of markers are present on the display. In the factory a harmonic generator is used for this purpose. The LINEARITY control, R102, is adjusted for equal spacing between the markers. The HORIZONTAL PHASE control also has an effect on Linearity and can be adjusted slightly to obtain optimum linearity.

BLOCK DIAGRAM



SWEEP OSCILLATOR

The sweep output is produced by the heterodyne method which combines the output of a tunable Sweep Oscillator with a second fixed tuned sweep oscillator. These two sweep oscillators are swept 180° out of phase which accounts for the wide sweep width since the sweep width of each sweep oscillator is added in the heterodyne output. This method of sweeping also produces excellent linearity since the non-linearities of each sweep oscillator are canceled in the heterodyne output.

Four diodes in a bridge circuit produce the mixing of the two fundamental frequencies and due to the balanced nature of this mixer, a high output is produced with a minimum of harmonic or spurious content. A low pass filter removes the fundamental frequencies and allows the output or heterodyne frequencies to pass out through the monitor and attenuator to the final output. The oscillator circuits are similar and have similar frequency versus voltage or frequency versus temperature effects to minimize drifts.

BLANKING CIRCUIT

The purpose of the blanking circuit is to produce a zero base line by removing B+ from the Sweep Oscillator during the sweep retrace. The blanking voltage is originated by a square wave producing circuit. A phased 6.3 volt sinewave is squared and amplified by the blanking tube. This square wave output of V201 controls V304 (EL84), the sweep oscillator voltage regulator tube, and thus deprives the Sweep Oscillator of voltage during one-half of each cycle. PHASE and WIDTH controls are provided for adjusting this blanking voltage to coincide with the horizontal and sweep drive signals.

AUTOMATIC OUTPUT LEVELING CIRCUITRY

A sample of the sweep oscillator output is detected by the monitor diode, located in the monitor block. This detected signal is then amplified and used to control the plate voltage of the sweep oscillator. The OUTPUT LEVEL control adjusts the bias on the first stage of the amplifier. This causes the DC levels in the entire amplifier to change, and varies the average B+ supplied to the sweep oscillator from a minimum of 25V to over 100V. A small decrease in the sampling voltage causes a large increase in the B+ supplied to the sweep oscillator, and thus counteracts any amplitude variation as the oscillator is tuned over the range.

The operation of this circuit and of the sweep oscillator can be checked at Pin 1 of V301. The waveform at this point will normally show a flat output level over the entire band. Adjusting the OUTPUT LEVEL will change this level.

To replace the monitor diode, remove the insulated holding screw in the monitor block and then remove diode from the block.

HORIZONTAL SWEEP OUTPUT CIRCUITRY

The sawtooth voltage for the scope horizontal sweep is produced by V101. A phased 6.3 volt sinewave is applied to the grid of one of the triode sections of V101. The tube then clips and amplifies the grid signal so that a square wave is produced at the plate. This square wave is then shaped by a RC network in the plate circuit to produce a linear sawtooth voltage. A potentiometer in this circuit allows the linearity of the waveform to be adjusted. This sawtooth voltage is then applied to the second triode section of V101, which is connected as a cathode follower. The output from the cathode follower is then applied to the Scope Horizontal Amplifier and compensates for the slight nonlinear characteristics of the vibrating sweep capacitor at high sweep widths. At sweep widths from minimum to about 50%, the vibrating sweep capacitor is quite linear. In order to maintain almost perfect linearity for all values of sweep width, a potentiometer is ganged with the sweep width potentiometer which automatically changes the scope horizontal sweep voltage from a sinusoidal waveform at low sweep width settings to a linear sawtooth waveform at the high sweep width settings.

POWER SUPPLY

The power transformer output of 140 volts AC is fed into a half wave voltage doubler using silicon rectifying elements CR1 and CR2. B+ is taken off the capacity input filter to provide +375 volts unregulated to the plates of V3, (B+ Regulator Pass Tube), V304 (Oscillator Pass Tube), and V4 (Marker B+ Pass Tube).

B+2 is the output of the electronic regulator circuit, consisting of V2 and V3, and provides +175 volts regulated. Potentiometer R1 controls the operating point of V2, regulator amplifier, and is set for proper B+2 output voltage.

B+3 is obtained by biasing the grid of V4 at approximately 85 volts positive, which causes current to flow through cathode resistor R20. The voltage at Pin 3, V4, is supplied to the Plug-In Markers and maintains its regulation due to the low impedance characteristics of the cathode follower circuit and provides approximately 100 volts.

The B- voltage is obtained by the half wave Silicon rectifier CR3. Regulator tube V1 maintains this voltage at -82 volts, and supplies bias voltage to the leveler circuit as well as a reference voltage for the electronic regulator.

Resistor R4 acts as a fuse, protecting the transformer and rectifiers from overload.

The primary of the power transformer is normally wired for 115 volt AC line operation. However, it can be converted to operate from a 230 volt AC source if desired. This conversion is described in the maintenance section.

MARKER SYSTEM DESCRIPTION

GENERAL

A sample of the sweep signal is mixed with the fundamental or a harmonic of the crystal plug-in marker units or external signal to produce beatnotes or birdies. These birdies are then amplified and superimposed upon the demodulated swept signal and applied to the vertical amplifier of the oscilloscope. The size and shape of the marker may be varied over a wide range by the SIZE and SHAPER Control of the birdy amplifier.

EXTERNAL MARKER INPUT

The CW signal from the external marker input is fed into a diode mixer, where it is mixed with a sample of the sweep signal to produce birdies. The resultant birdy is then fed into the birdy-by-pass amplifier.

PLUG-IN MARKERS

This unit has provisions for a maximum of eight single frequency (C Type) crystal markers, eight harmonic (CH type) crystal markers, or four harmonic (CDH type), or any combination. Each CDH type marker occupies the space of two C or CH type.

Two sweep sample outputs are available from the sweep oscillator, in order to minimize coupling between marker signals. For optimum operation harmonic and single frequency markers should not be fed from the same sweep sample line.

SINGLE FREQUENCY MARKERS (C TYPE)

These crystal markers are self-contained plug-in units. Additional units at other frequencies (within the range of the sweep generator) may be ordered and substituted for the original units.

The crystal oscillator units include the tube, crystal oscillator tuning, crystal diode mixer, and a tuned circuit selecting the sweep input frequency. A test point is provided for easy adjustment of the overtone crystal oscillator (this circuit used above 12 mc.). In making this adjustment, the crystal oscillator coil slug is adjusted for near maximum voltage at the test point. This is usually in the order of 2-5 volts as measured with a VTVM. The adjustment should be made just slightly off the peak on the low inductance side, since the effects of tuning are critical on the other side of the resonance curve. Crystal oscillators below 12 mc. are Pierce type oscillator circuits which require no tuning.

By tuning the sweep sample coil, the frequency of the sweep input signal can be varied and thus minimize unwanted markers generated from other harmonics of the crystal oscillator. The amplitude can be varied by adjusting the coupling.

HARMONIC MARKERS

Harmonics of a crystal-controlled oscillator are mixed with a portion of the sweep signal to produce a display of markers at regular intervals across the sweep range.

CH TYPE - This type utilizes a single tube and produces harmonic markers over a limited range.

CDH TYPE - This type uses two tubes and therefore will produce harmonics over a much larger range than the CH type. For example, the CH type, 1 mc., harmonic generator will produce harmonic markers to approximately 25 mc. where the CDH type, 1 mc., harmonic generator will produce markers to over 300 mc.
(See our literature on plug-in markers for additional information).

POWER SUPPLY: Since a defect in the power supply will affect all circuits, it should be checked for proper operation before proceeding to other circuits.

SUPPLY	NOMINAL VALUE	NORMAL VARIATION	NORMAL RIPPLE	WIRE COLOR*
AC Line	115V	----------	------	------
B+1	375	±15 Volts	6 to 15 volts	Red
B+2	175	±.5 Volts	12 to 25 millivolts	Blue
B+3	100	±5-10 Volts	15 millivolts to .5 volts	Orange
B-	-82	±2 Volts	100 millivolts	White
6.3 "A"	6.3V AC	Main filament supply		Green
6.3 "B"	6.3V AC	180° out of phase with supply "A". Source of phasing and filament voltages.		Gray
6.3 "C"	6.3V AC	Isolated filament voltage for tubes with cathodes above ground.		Brown

NEXT: If power supply is operating normal, use the block diagram to isolate the trouble to a major section. Check tubes, diodes, and adjustment of Front Panel and printed wiring board controls located within that section (see Page 7 for adjustment procedure). By the use of the schematic, ordinary difficulties encountered can be readily located and remedied. The following trouble-shooting chart is an additional aid to servicing:

SYMPTOM	POSSIBLE CAUSE AND REMEDIES
Pilot Light Off and Unit Fails to Operate	Fuse open - replace. If second fuse opens - look for cause of overload, shorted wiring, components, etc.
B+1 Off Value or Excessive Ripple	Check R4, C1, C2, CR1, and CR2.
B+2 Off Value or Excessive Ripple	Check R1 for proper adjustment. Check R15, it will burn out if B+2 is overloaded. Check V1, V2, V3, tubes and circuitry.
B+3 Off Value or Excessive Ripple	Check R17 and R21 (these resistors adjust the voltage on the grid of V4, a cathode follower, which in turn determines the voltage on the cathode). Check R18 (this resistor will burn out if B+3 is overloaded). Check V4 and C2.
B- Off Value or Excessive Ripple	Check C3, C4, C5, CR3, R3, R5, and R6. Check V1 to see if it is lit properly (should be a steady orange glow).

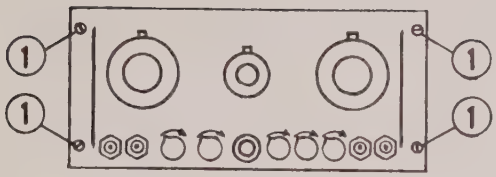
*Wire colors do not apply to shielded wires - single wires only.

V1 Not Lit Properly	If replacing V1 and checking the above parts does not remedy the trouble, check the line voltage. Low line voltage could cause this trouble. Reducing the value of R3 slightly will usually eliminate this difficulty.
RF Output is Low or Zero	Check R314 - this resistor will burn out if the B+ to the Sweep Oscillator is overloaded. Check B+ to the Sweep Oscillator, cathode of V304. It should be a positive square wave of 25-100 volts and should vary as the OUTPUT LEVEL control varies. If it is normal, look for RF difficulties, defective tube, components, shorted or open wiring, etc. Replace mixer diodes in sweeper box, observe polarity. If the voltage is low and does not respond to the LEVEL control, remove first V303 and then V201. When either of these tubes conducts, the voltage on the grid of V304 (pin 2) is reduced and thus decreases the B+ to the Sweep Oscillator. If removal of V201 allows the B+ on V304 (pin 3) to return to normal, check the blanking tube, controls, and associated circuitry. If removal of V303 causes the B+ to return to normal, check the LEVELER controls, V301 and V302, tubes, and associated circuitry.
Poor Leveling	Replace monitor diode. Also replace V301, V302, and V303. V301 is the most critical since it is in the first stage of the DC coupled amplifier. Resetting the printed circuit LEVEL controls is sometimes necessary if these tubes are replaced.
Weak Markers	Replace IN82 or IN34 crystal diode mixer. Check Birdy-By-Pass Amplifier, tubes and circuitry.
No Horizontal Output	Look for difficulty in the sawtooth circuitry V101, using the printed circuit board layout and schematic to check waveforms and voltages.

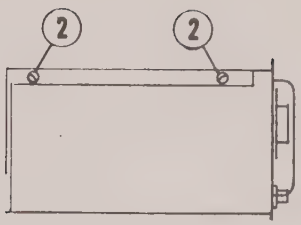
CONVERSION FOR 230 VOLT POWER LINES

The dual primary of the power transformer is normally wired in parallel for use on 115 volt AC lines. If desired, the windings can easily be reconnected in series for use with 230 volt power. With the aid of the Chassis Layout, bottom view, locate terminals 1, 2, 3, and 4. Remove the jumper wires between terminals 1 and 2 and between terminals 3 and 4. Then install a jumper wire between terminals 2 and 3.

RACK MOUNTED UNIT



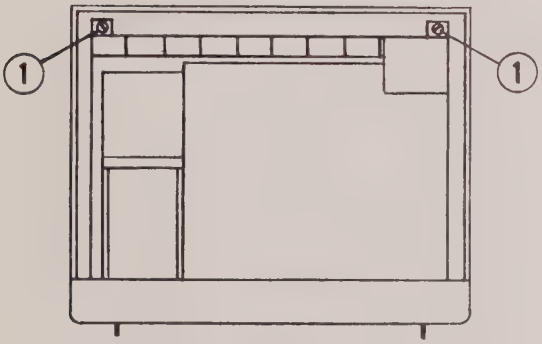
FRONT



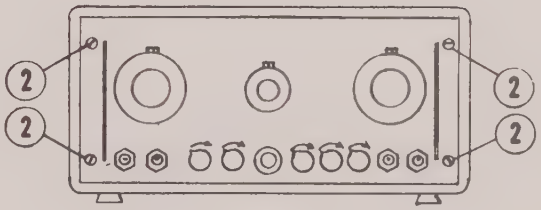
SIDE

Unit has front panel slotted or drilled for standard RTMA Mounting. Position unit in rack and install mounting screws in holes marked 1.
Dust cover removal: Remove four #8-32 thread-cutting screws, marked 2 (two on each side) and lift off cover for easy access to chassis.

CABINET MOUNTED UNIT



TOP



FRONT

To remove chassis from cabinet; first remove the two #8-32 screws (marked 1 on top view above) at the back of the chassis (one on each side). These screws fasten the chassis to the cabinet guide rails. Second, remove the four #10-32 screws (marked 2 in front view above). The screws hold the panel to the cabinet.

Slide chassis out of cabinet by pulling forward on the two front panel handles.

To replace chassis in cabinet, insert the flanges on the bottom of the chassis side panels into the slot of the cabinet guide rails. Push chassis back into cabinet far enough for the slots in the side panel flanges to align with the retained nut in guide rail. Install the two #8-32 screws and tighten securely. Replace the four #10-32 screws in the front panel.

PART VALUE INFORMATION

SCHEMATIC PART DESIGNATION	
C	Capacitor
CR	Crystal Rectifier, Germanium Diode
F	Fuse
I	Incandescent Pilot Light
J	Jack or termination, Coaxial Connector
K	Cable
L	Coil
M	Meter or Motor
P	Plug, Coaxial Connector
R	Resistor, Fixed or Variable
S	Switch
T	Transformer
V	Tube
Z	Miscellaneous

SCHEMATIC VALUE ABBREVIATION	
Ω	ohms
K Ω	1,000 ohms
M Ω	1,000,000 ohms (megohms)
µf, uf	Microfarad
pf	Picofarad
µh, uh	Microhenry
mh	Millihenry

RESISTORS - All resistors are 1/2 watt ± 10%, and are shown in ohms, unless otherwise specified.

NOTE: Resistors in the attenuator pads are ± 2%.

CAPACITORS - All Capacitors are shown in picofarads (pf) unless otherwise specified.

COILS - All coils are shown in microhenries (µh) unless otherwise specified.

PARTS LOCATION - F.P. Front Panel
P.C.B. Printed Circuit Board
R.P. Rear Panel
C.H. Chassis
T.P. Test Point

PARTS NUMBERS - LOCATION INFORMATION

1 - 99 - Power Supply
101 - 199 - Horizontal and Alternate Sweep Drive Circuit
201 - 299 - Blanking
301 - 399 - Leveler
401 - 499 - Birdy-By-Pass
501 - 599 - Mixer & Plug-In Markers
601 - 699 - Variable Markers
701 - 799 - Attenuators
801 - 899 - Sweep Oscillator and Sweep Drive Circuit
901 - 999 - Modifications and Special Circuits

*Indicates value of component adjusted at factory, and may deviate from value shown on print.

—○— 16 Indicates printed circuit board terminal.

N O T I C E

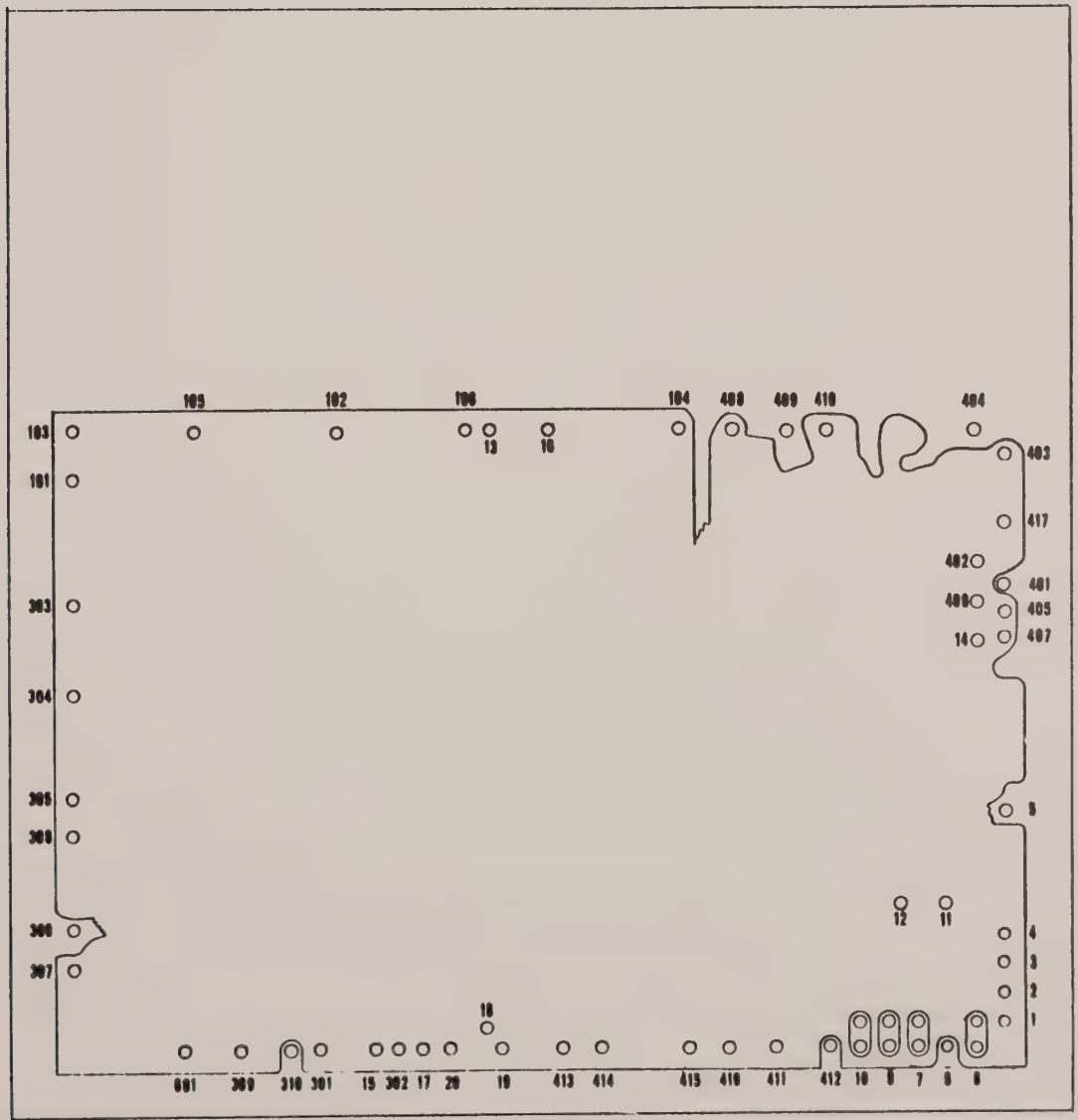
RED LACQUER IS USED TO INDICATE FASTENINGS THAT SHOULD NOT BE DISTURBED FOR ORDINARY SERVICE, AND TO SECURE ADJUSTABLE CONTROLS.

CHASSIS LAYOUT

BOTTOM VIEW

TERMINALS

FRONT



PARTS LIST

CIRCUIT REF.	DESCRIPTION	PART NO.
	CAPACITORS	
C1	Fixed, electrolytic, 80 μf., 250 VDCW	C-314
C2A, B	Fixed, dual electrolytic, 80 μf., 450 VDCW 20 μf., 250 VDCW	C-308
C3	Fixed, electrolytic, 30 μf., 250 VDCW	C-313
C4	Fixed, electrolytic, 30 μf., 250 VDCW	C-313
C5	Fixed, electrolytic, 30 μf., 150 VDCW	C-312
C6	Fixed, paper dielectric, .22 μf., ±20%, 200 VDCW	C-215
C7	Fixed, paper dielectric, .22 μf., ±20%, 400 VDCW	C-217
C8 thru C100	These circuit references not assigned.	
C101	Fixed, paper dielectric, .1 μf., ±20%, 200 VDCW	C-203
C102	Fixed, paper dielectric, .1 μf., ±20%, 200 VDCW	C-203
C103	Fixed, paper dielectric, .01 μf., ±20%, 600 VDCW	C-210
C104	Fixed, dura-mica, 4700 μμf., ±10%, 300 VDCW (this part subject to change)	C-54
C105	Fixed, paper dielectric, .47 μf., ±20%, 200 VDCW	C-216
C106	Fixed, dura-mica, 2200 μμf., ±10%, 500 VDCW (this part subject to change)	C-24
C107 thru C200	These circuit references not assigned.	
C201	Fixed, paper dielectric, .1 μf., ±20%, 200 VDCW	C-203
C202	Fixed, paper dielectric, .1 μf., ±20%, 200 VDCW	C-203
C203 thru C300	These circuit references not assigned.	
C301	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C302	Fixed, ceramic disc., 50 μμf., ±10%, NPO, 1000VDCW	C-11

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	CAPACITORS CONT.	
C303	Fixed, ceramic disc., 33 μμf., ±10%, NPO, 1000 VDCW (this part subject to change)	C-10
C304	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C305 thru C400	These circuit references not assigned.	
C401	Fixed, ceramic disc., 120 μμf., ±10%, 600 VDCW, N750	C-14
C402	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C403	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C404	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C405	Fixed, ceramic disc., 1000 μμf., GMV, 600 VDCW	C-19
C406	Fixed, ceramic disc., 1000 μμf., GMV, 600 VDCW	C-19
C407	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C408	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C409	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C410	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C411	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C412 thru C500	These circuit references not assigned.	
C501	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C502 thru C800	These circuit references not assigned.	
C801	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C802	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C803	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C804	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C805	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C806	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	CAPACITORS CONT.	
C807	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C808	Fixed, solder-in, ceramic disc., 4 μμf., ±5%, NPO, 500 VDCW	C-41
C809	Fixed, solder-in, ceramic disc., 4 μμf., ±5%, NPO, 500 VDCW	C-41
C810	Fixed, composition, .5 μμf., ±10%, 500 VDCW	C-29
C811	Fixed, mica, 400 μμf.,	Not assigned
C812	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C813	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C814	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C815	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C816	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C817	Fixed, ceramic feedthru, 1000 μμf., GMV, 1000 VDCW	C-39
C818	Fixed, composition, 4 μμf., ±10%, 500 VDCW (this part subject to change)	C-35
C819	Fixed, ceramic disc., .01 μf., GMV, 600 VDCW	C-20
C820	Fixed, electrolytic, 100 μf., 12 VDCW (this part subject to change)	C-319
C821	Fixed, electrolytic, 100 μf., 12 VDCW (this part subject to change)	C-319
	RECTIFIERS	
CR1	Silicon,	D-5
CR2	Silicon,	D-5
CR3	Silicon,	D-5
CR4 thru CR500	These circuit references not assigned.	
CR501	Crystal Diode, 1N82	D-1
CR502 thru CR800	These circuit references not assigned.	

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	RECTIFIERS CONT.	
CR801	Crystal Diode, 1N21	D-3
CR802	Crystal Diode, 1N82	D-1
CR803	Crystal Diode, 1N82	D-1
CR804	Crystal Diode, 1N82	D-1
CR805	Crystal Diode, 1N82	D-1
	FUSE	
F1	3AG, 2 amp, 250 V	MP-6
	LAMP	
I1	Incandescent, #47 6-8 V	MP-5
	BNC JACKS AND TERMINATORS	
J101	Jack, receptacle, BNC Dage type 2545-1	J-10
J102 thru J400	These circuit references not assigned.	
J401	Jack, receptacle, BNC Dage type 2545-1	J-10
J402	Jack, receptacle, BNC Dage type 2545-1	J-10
J403 thru J500	These circuit references not assigned.	
J501	Jack, receptacle, UG-625/U	J-7
J502	Terminator, cable, MX1684/U	J-9
J503	Terminator, cable, MX1684/U	J-9
J504	Terminator, cable, MX1684/U	J-9
J505	Jack, cable, BNC Dage type 2559-1	J-11
J506	Jack, resistor, terminator assembly	J-23
J507	Jack, resistor, terminator assembly	J-23
J508 thru J700	These circuit references not assigned.	
J701	Jack, receptacle, flange mounted	J-21

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	BNC JACKS AND TERMINATORS CONT.	
J702	Jack, receptacle, flange mounted	J-21
J703	Jack, cable, BNC Dage type 2559-1	J-11
J704 thru J800	These circuit references not assigned.	
J801	Jack, receptacle, flange mounted, UG-185/U	J-3
J802	Jack, receptacle, right angle, UG-535/U	J-6
J803	Jack, receptacle, flange mounted, UG-185/U	J-3
J804	Jack, receptacle, UG-261B/U (part of low-pass filter)	J-16
J805	Terminator, cable, MX1530/U	J-8
J806	Terminator, cable, MX1530/U	J-8
	COIL	
L401	Adjustable, 6-11 mh.	L-23
L402 thru L800	These circuit references not assigned.	
L801	Fixed, .3 μh.	L-104
L802	Fixed, 2.2 μh.	L-101
L803	Fixed, 2.2 μh.	L-101
L804	Fixed, 2.2 μh.	L-100
L805	Fixed, .6 μh.	L-106
L806	Inductor, fixed (factory adjusted RF inductor) (this part subject to change)	Not assigned.
L807	Fixed, .3 μh.	L-104
L808	Fixed, 2.2 μh.	L-101
L809	Fixed, 2.2 μh.	L-101
L810	Fixed, .6 μh.	L-106
L811	Inductor, fixed (factory adjusted RF inductor) (this part subject to change)	Not assigned.
L812	Inductor, fixed (factory adjusted RF inductor) (this part subject to change)	Not assigned.

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	COILS CONT.	
L813	Inductor, fixed (factory adjusted RF inductor) (this part subject to change)	Not assigned
L814	Inductor, variable (this part subject to change)	09003
	BNC PLUGS	
P506	Cable, UG-88B/U	J-1
P507	Cable, UG-88B/U	J-1
P508 thru P700	These circuit references not assigned.	
P701	Cable, UG-88B/U	J-1
P702	Cable, UG-88B/U	J-1
P703 thru P800	These circuit references not assigned	
P801	Cable, UG-88B/U	J-1
P802	Cable, UG-88B/U	J-1
P803	Cable, UG-88B/U	J-1
P804	Cable, UG-88B/U	J-1
	RESISTORS	
R1	Variable, composition, 50KΩ, 1/4W	R-725
R2	This circuit reference not assigned.	
R3	Fixed, wirewound, 10KΩ, ±10%, 5W (this part subject to change)	R-404
R4	Fixed, composition, 4.7Ω, ±10%, 1W	R-206
R5	Fixed, composition, 4.7KΩ, ±10%, 2W	R-306
R6	Fixed, composition, 1KΩ, ±10%, 1W	R-208
R7	Fixed, composition, 4.7Ω, ±10%, 1W	R-206
R8	Fixed, composition, 47KΩ, ±10%, 1/2W	R-27
R9	Fixed, composition, 47KΩ, ±10%, 2W	R-305
R10	Fixed, composition, 100KΩ, ±10%, 2W	R-303
R11	Fixed, composition, 1MΩ, ±10%, 1/2W	R-31
R12	Fixed, composition, 22Ω, ±10%, 1/2W	R-11

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	RESISTORS CONT.	
R13	Fixed, composition, 27KΩ, ±10%, 2W	R-304
R14	Fixed, composition, 150KΩ, ±10%, 1/2W	R-98
R15	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R16	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R17	Fixed, composition, 220KΩ, ±10%, 1/2W	R-44
R18	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R19	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R20	Fixed, composition, 220KΩ, ±10%, 1/2W	R-44
R21	Fixed, composition, 220KΩ, ±10%, 1/2W	R-44
R22	Fixed, composition, 220KΩ, ±10%, 1/2W	R-44
R23	Fixed, composition, 220KΩ, ±10%, 1/2W	R-44
R24 thru R100	These circuit references not assigned.	
R101	Variable, composition, 200KΩ, 1/4W	R-724
R102	Variable, composition, 2MΩ, 1/4W	R-729
R103	Variable, composition, 100KΩ. 1/4W	R-732
R104	Fixed, composition, 2.2KΩ, ±10%, 1/2W (this part subject to change)	R-20
R105	Fixed, composition, 100KΩ, ±10%, 1/2W	R-28
R106	Fixed, composition, 560KΩ, ±10%, 1/2W	R-29
R107	Fixed, composition, 1MΩ, ±10%, 1/2W	R-31
R108	Fixed, composition, 100KΩ, 1/4W (this part subject to change)	R-28
R109	Fixed, composition, 27K, ±10%, 1/2W (this part subject to change)	R-25
R110	Fixed, composition, 220KΩ, ±10%, 1/2W	R-44
R111 thru R200	These circuit references not assigned.	

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	RESISTORS CONT.	
R201	Variable, composition, 200K, 1/4W	R-724
R202	Variable, composition, 1MΩ, 1/4W	R-728
R203	Fixed, composition, 560KΩ, ±10%, 1/2W	R-29
R204	Fixed, composition, 560KΩ, ±10%, 1/2W	R-29
R205	Fixed, composition, 560K, ±10%, 1/2W (this part subject to change)	R-29
R206	Fixed, composition, 560KΩ, ±10%, 1/2W	R-29
R207 thru R300	These circuit references not assigned.	
R301	Variable, composition, 50KΩ, 1/4W	R-725
R302	Variable, composition, 50KΩ, 1/4W	R-725
R303	Variable, composition, 200KΩ, 1/2W	R-44
R304	Fixed, composition, 560KΩ, ±10%, 1/2W	R-29
R305	Fixed, composition, 10KΩ, ±10%, 1/2W	R-23
R306	Fixed, composition, 1MΩ, ±10%, 1/2W	R-31
R307	Fixed, composition, 47KΩ, ±10%, 1/2W	R-27
R308	Fixed, composition, 680KΩ, ±10%, 1/2W	R-30
R309	Fixed, composition, 10KΩ, ±10%, 1/2W	R-23
R310	Fixed, composition, 39KΩ, ±10%, 1/2W	R-26
R311	Fixed, composition, 100KΩ, ±10%, 1/2W	R-28
R312	Fixed, composition, 10KΩ, ±10%, 1/2W	R-23
R313	Fixed, composition, 1MΩ, ±10%, 1/2W	R-31
R314	Fixed, composition, 82Ω, ±10%, 1/2W	R-54
R315	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R316	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R317 thru R400	These circuit references not assigned.	

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	RESISTORS CONT.	
R401	Fixed, composition, 47KΩ, ±10%, 1/2W	R-27
R402	Fixed, composition, 100KΩ, ±10%, 1/2W	R-28
R403	Fixed, composition, 4.7KΩ, ±10%, 1/2W	R-21
R404	Fixed, composition, 47KΩ, ±10%, 1/2W	R-27
R405	Fixed, composition, 22KΩ, ±10%, 1/2W	R-24
R406	Fixed, composition, 10KΩ, ±10%, 1/2W	R-23
R407	Fixed, composition, 10KΩ, ±10%, 1/2W	R-23
R408	Variable, composition, 100KΩ, 1/2W	R-706
R409	Fixed, composition, 100KΩ, ±10%, 1/2W	R-28
R410	Fixed, composition, 4.7KΩ, ±10%, 1/2W	R-21
R411	Variable, composition, 100KΩ, 1/2W	R-706
R412	Fixed, composition, 47KΩ, ±10%, 2W	R-305
R413	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R414	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R415	Fixed, composition, 1KΩ, ±10%, 1/2W	R-18
R416	This circuit reference not assigned.	
R417	Fixed, composition, 1KΩ, ±10%, 1/2W	R-18
R418	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R419	Fixed, composition, 100Ω, ±10%, 1/2W	R-15
R420	Fixed, composition, 1KΩ, ±10%, 1/2W	R-18
R421	Fixed, composition, 1KΩ, ±10%, 1/2W	R-18
R422	Fixed, composition, 4.7KΩ, ±10%, 1/2W	R-21
R423	Variable, composition, 100KΩ, 1/2W	R-706
R424	Fixed, composition, 100KΩ, ±10%, 1/2W	R-28
R425	Fixed, composition, 5.6KΩ, ±10%, 1/2W	R-22

PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	RESISTORS CONT.	
R426	This circuit reference not assigned.	
R427	Fixed, composition, 10KΩ, ±10%, 1/2W	R-23
R428 thru R500	These circuit references not assigned.	
R501	Fixed, composition, 220Ω, ±10%, 1/2W	R-39
R502	Fixed, composition, 470Ω, ±10%, 1/2W	R-42
R503	Fixed, composition, 56Ω, ±5%, 1/2W	R-53
R504	Fixed, composition, 56Ω, ±5%, 1/2W	R-53
R505	Fixed, composition, 120Ω, ±10%, 1/2W	R-16
R506	Fixed, composition, 120Ω, ±10%, 1/2W	R-16
R507	Fixed, composition, 56Ω, ±5%, 1/2W (part of J506)	R-53
R508	Fixed, composition, 56Ω, ±5%, 1/2W (part of J507)	R-53
R509 thru R800	These circuit references not assigned.	
R801A, B, C	Variable, wirewound, 6Ω, 2W; 6Ω, 2W; 100KΩ, 1/2W	R-735A
R802	Variable, wirewound, 25Ω, 2W	R-713
R803	Variable, wirewound, 25Ω, 2W	R-713
R804	Fixed, wirewound, 7.5Ω, 5W, ±10%	R-403
R805	Fixed, composition, 330Ω, ±10%, 1/2W	R-17
R806	Fixed, composition, 17.6Ω, ±10%, 1/2W	Not assigned
R807	Fixed, composition, 292Ω, ±10%, 1/2W	Not assigned
R808	Fixed, composition, 292Ω, ±10%, 1/2W	Not assigned
R809	Fixed, composition, 120Ω, ±10%, 1/2W	R-16
R810	Fixed, composition, 5.6KΩ, ±10%, 1/2W	R-22
R811	Fixed, composition, 180Ω, ±10%, 1/2W	R-52
R812	Fixed, composition, 120Ω, ±10%, 1/2W	R-16

PARTS LIST
(Continued)

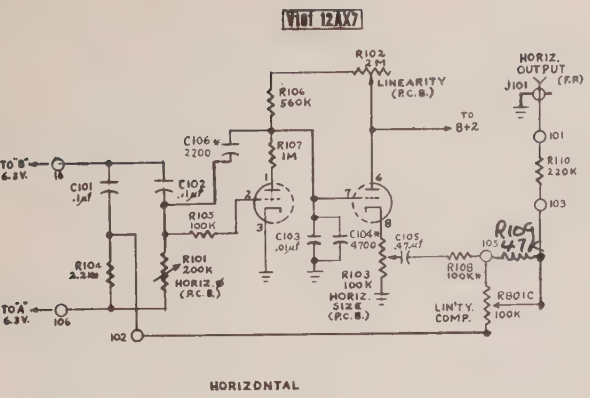
CIRCUIT REF.	DESCRIPTION	PART NO.
	RESISTORS CONT.	
R813	Fixed, composition, 4.7KΩ, ±10%, 1/2W	R-21
R814	Fixed, wirewound, 7.5Ω, ±10%, 5W	R-403
R815	Fixed, composition, 120Ω, ±10%, 1/2W	R-16
	SWITCHES	
S1	Toggle, SPST	SW-10
S2 thru S500	These circuit references not assigned.	
S501 thru S508	Toggle SPST	SW-10
	TRANSFORMER	
T1	Power	T-9A
	TUBES	
V1	Electronic: 5651 (voltage regulator)	VT-17
V2	Electronic: 6AU6	VT-5
V3	Electronic: EL84/6BQ5	VT-16
V4	Electronic: EL84/6BQ5	VT-16
V5 thru V100	These circuit references not assigned.	
V101	Electronic: 12AX7	VT-13
V102 thru V200	These circuit references not assigned.	
V201	Electronic: 12AX7	VT-13
V202 thru V300	These circuit references not assigned.	
V301	Electronic: 6AU6 (6EW6 in some units)	VT-5
V302	Electronic: 12AX7	VT-13
V303	Electronic: 6AU6	VT-5
V304	Electronic: EL84/6BQ5	VT-16
V305 thru V400	These circuit references not assigned.	

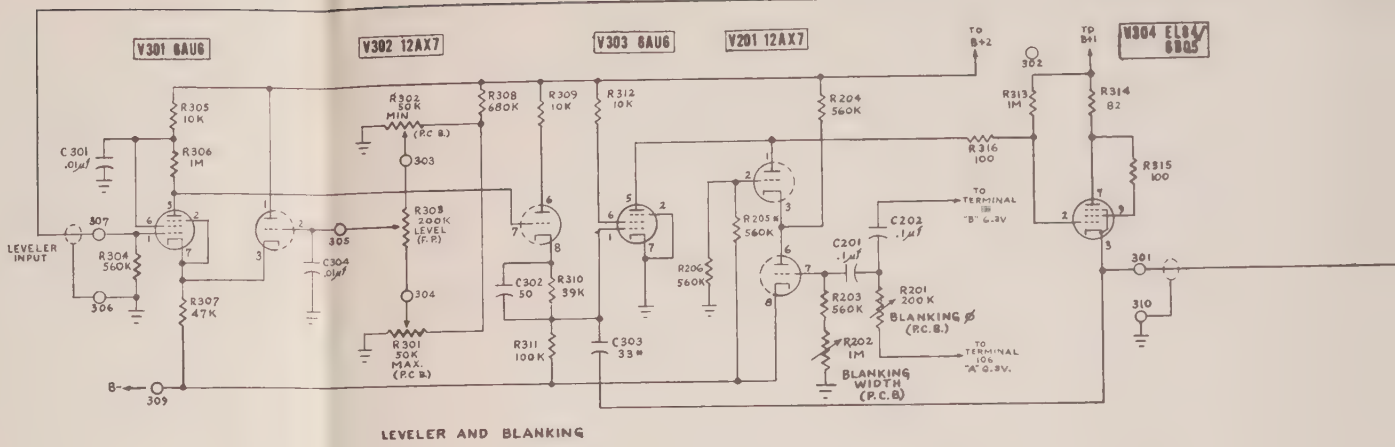
PARTS LIST
(Continued)

CIRCUIT REF.	DESCRIPTION	PART NO.
	TUBES CONT.	
V401	Electronic: 12AX7	VT-13
V402	Electronic: 12AX7	VT-13
V403	Electronic: 12AX7	VT-13
V404	Electronic: 12AX7	VT-13
V405 thru V800	These circuit references not assigned.	
V801	Electronic: 6AF4 Tube types 6AF4A and 6DZ4 are used interchangeably in this instrument.	VT-4
V802	Electronic: 6AF4 The 6DZ4 is Telonic Part No. VT-5A	VT-4
	MISCELLANEOUS	
Z501	Socket, 6 pin	S-11
Z502	Socket, 6 pin	S-11
Z503	Socket, 6 pin	S-11
Z504	Socket, 6 pin	S-11
Z505	Socket, 6 pin	S-11
Z506	Socket, 6 pin	S-11
Z507	Socket, 6 pin	S-11
Z508	Socket, 6 pin	S-11
Z509 thru Z700	These circuit references not assigned.	
Z701	Attenuator, turret	
Z702 thru Z800	These circuit references not assigned.	
Z801	Wobbulator	
Z802	Wobbulator	
	Bushing, AC line cord, strain relief	H-23
	Bushing, tuning shaft ground	SM-11
	Cord, AC line, 3 conductor	W-46
	Filter, low pass	06001

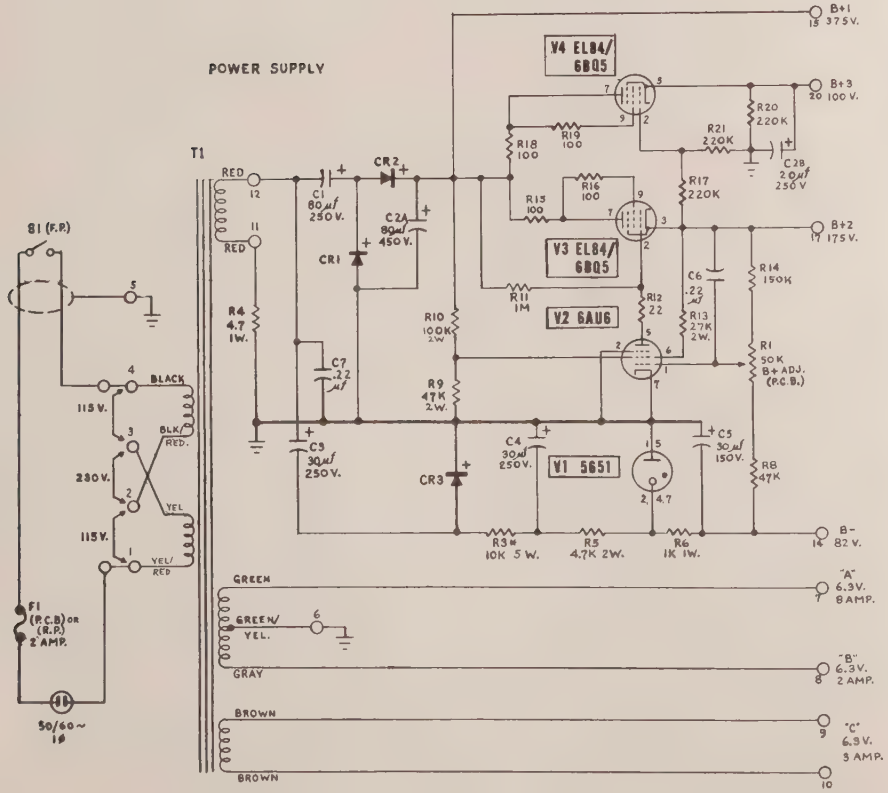
PARTS LIST
(Continued)

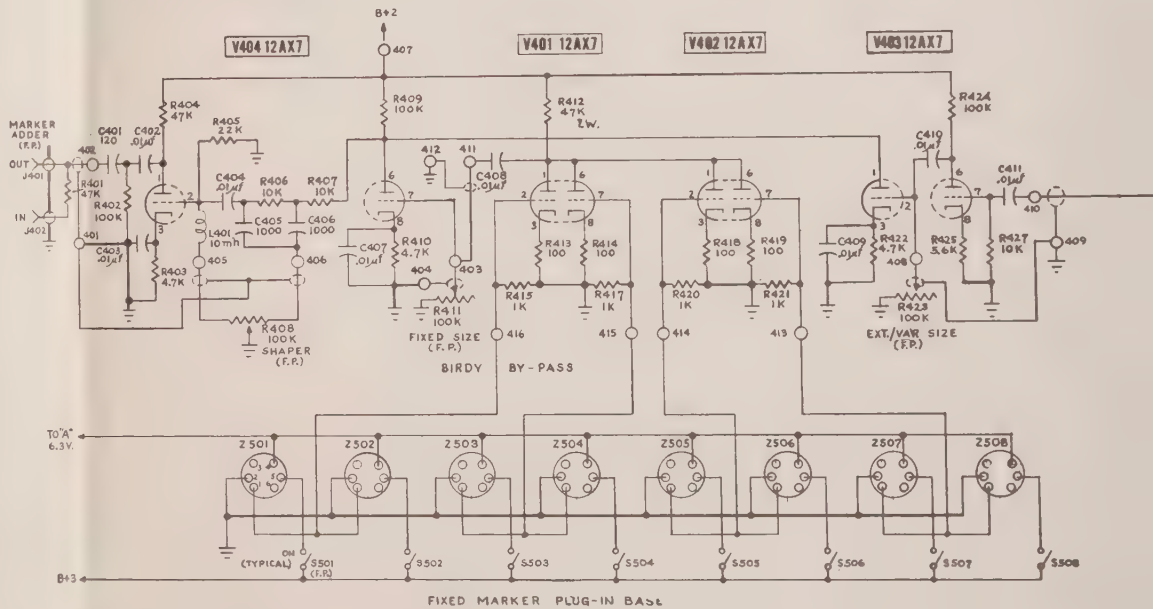
CIRCUIT REF.	DESCRIPTION	PART NO.
	MISCELLANEOUS CONT.	
	Fuseholder	S-27
	Knob: Attenuator	K-2
	Knob, round 2"	K-1
	Knob, round 5/8"	K-4
	Nib, tuning	SM-2
	Socket, diode	S-9
	Socket, 7 pin mica filled	S-36
	Socket, 7 pin printed circuit	S-4
	Socket, 9 pin printed circuit	S-5
	Socket Assembly, Pilot Light	MP-3





LEVELER AND BLANKING





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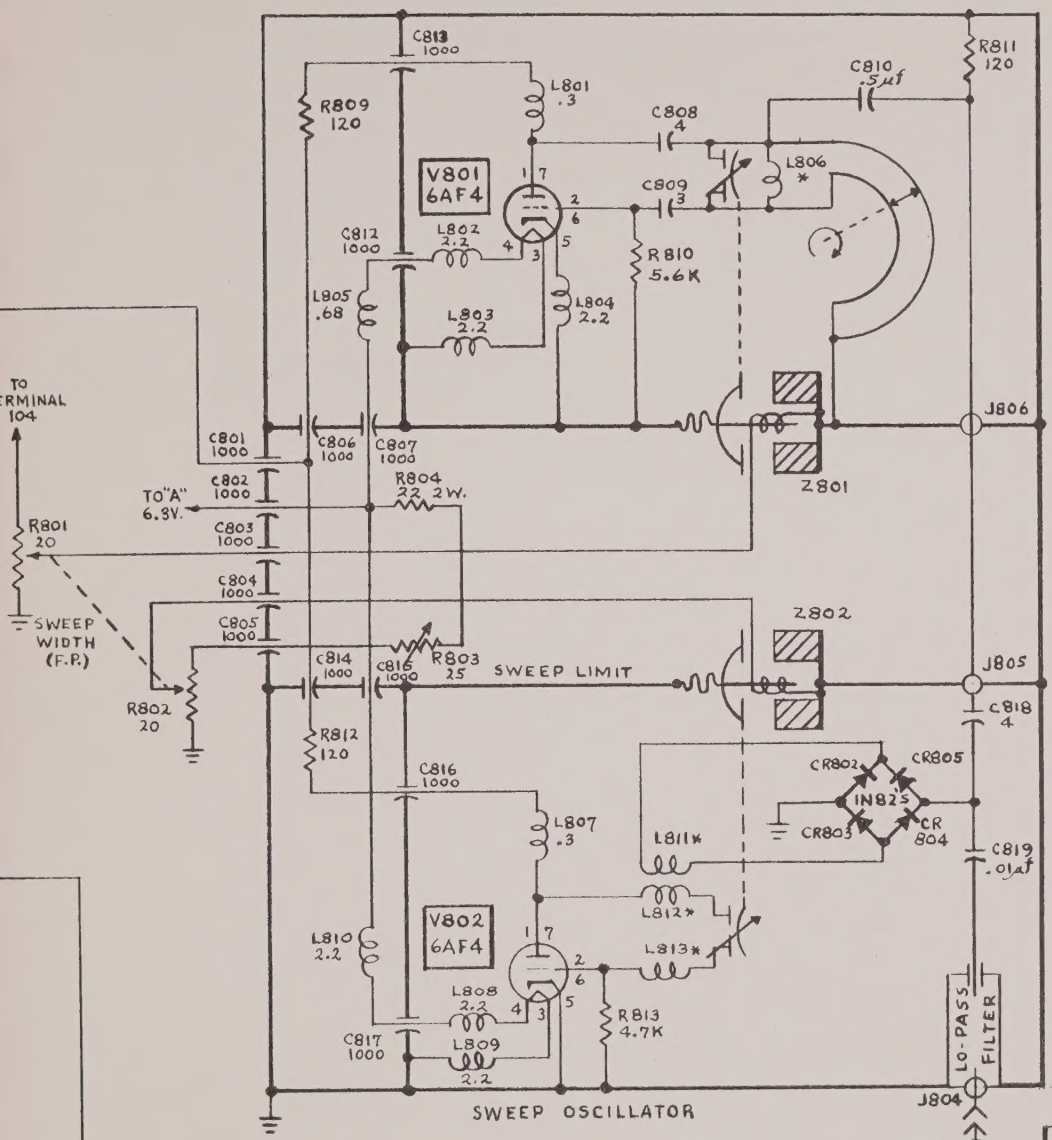
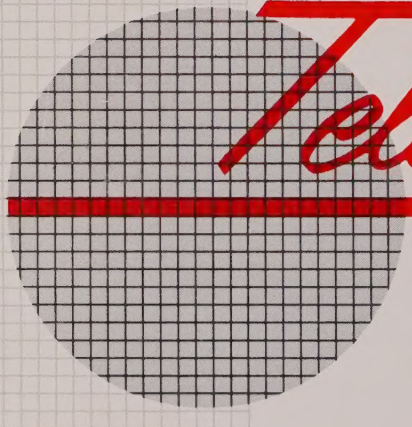


Tube types 6AF4A and 6DZ4 are used interchangeably in this instrument. The 6DZ4 is Telonic Part No. VT-51

SWEEPER
H3

Telonic INDUSTRIES, INC.
BEECH GROVE, INDIANA



Telonic INDUSTRIES INC.

BEECH GROVE, INDIANA